



Canada

EMC & RF Test Report

As per

**RSS-247 Issue 2:2017
&
FCC Part 15 Subpart 15.247:2015**

**Unlicensed Intentional Radiators
(FHSS)**
on the

EB-SMSWV-01

Issued by:

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Project Engineer

Testing produced for



See Appendix A for full
client &EUT details.



Testing Laboratory
Certificate #2955.02



R-4023, G-506
C-4498, T-1246



Registration #
CA6844

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

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Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Report Scope

This report addresses the EMC verification testing and test results of the **Ecobee Inc.'s EB-SMSWV-01**, and is herein referred to as EUT (Equipment Under Test). The EUT was tested for compliance against the following standards:

RSS-247 Issue 2:2015

FCC Part 15 Subpart C 15.247:2015

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by any government, accreditation agency, or TÜV SÜD Canada Inc.

Opinions or interpretations expressed in this report, if any, are outside the scope of TÜV SÜD Canada Inc. accreditations. Any opinions expressed do not necessarily reflect the opinions of TÜV SÜD Canada Inc., unless otherwise stated.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Summary

The results contained in this report relate only to the item(s) tested.

EUT:	EB-SMSWV-01
FCC Certification #, FCC ID:	WR9EBSMSW1V001
Industry Canada Certification #, IC:	7981A- EBSMSW1V001
EUT passed all tests performed	Yes
Tests conducted by	Min Xie

For testing dates, see "Testing Environmental Conditions and Dates".

Client	Ecobee Inc.	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada
Product	EB-SMSWV-01		
Standard(s)			

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS GEN Table 6	Restricted Bands for intentional operation	None within band	Pass See description
FCC 15.207 RSS GEN Table 3	Power line conducted emissions	QuasiPeak Average	N/A See Justification
FCC 15.209 RSS GEN Table 4	Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)(1) RSS 247 5.1 (2)	Channel Separation	> 25 kHz or 20 dB BW	Pass
FCC 15.247(a)(1)(i) RSS 247 5.1 (3)	Number of channels	> 50	Pass
FCC 15.247(a)(1)(i) RSS 247 5.1 (3)	Time of occupancy	< 0.4 sec in 20 sec period	Pass
FCC 15.247(b) RSS 247 5.4(1)	Max output power	< 1 Watt	Pass
FCC 15.247(b)(4) RSS 247 5.4 (3)	Antenna Gain	< 6 dBi	Pass See Justification
FCC 15.247(d) RSS 247 5.5	Antenna conducted spurious	> 20 dBc	Pass
FCC 15.247(h) RSS GEN 247 5.1	FHSS Intelligence	No coordination	Pass See Justification
FCC 15.247(i) RSS-102	Maximum Permissible Exposure	> 20 cm separation.	Pass See justification and calculations
Overall Result			PASS

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a 'PASS' grade. If not 'FAIL' grade will be issued. Note that 'PASS' / 'FAIL' grade is independent of any measurement uncertainties. A 'PASS' / 'FAIL' grade within measurement uncertainty is marked with a '*'.

Client	Ecobee Inc.
Product	EB-SMSWV-01
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015



Notes, Justifications, or Deviations

The following notes, justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS-247 section 5.5), the unit uses a 1.5 dBi flex PCB antenna which is less than 6 dBi gain.

For the Restricted Bands of operation, the EUT is designed to only operate between 902 – 928 MHz.

The EUT is not a hybrid system and FCC 15.247 (f) does not apply to it.

The EUT does not coordinate transmission with any other FHSS to avoid simultaneous occupation of hopping frequencies.

The EUT contains a 902 – 928 MHz FHSS transmitter and a 2400 – 2483.5 MHz DTS transmitter. The Firmware guarantees simultaneous will not occur. Antenna co-location testing is therefore not applicable.

For maximum permissible exposure, this device operates at less than 1 Watt at 902 - 928 MHz and is designed to operate greater than 20 cm from any personnel during normal operation. No testing is required, however worst case calculated exposure compliance was shown in the RF Exposure exhibits.

Sample Calculation(s)

Radiated Emission Test

Margin = Limit – (Received Signal + Antenna Factor + Cable Loss – Pre-Amp Gain)

Margin = 50.5dB μ V/m – (50dB μ V + 10dB + 2.5dB – 20dB)

Margin = 8.0 dB (pass)

Power Line Conducted Emission Test

Margin = Limit – (Received Signal + Attenuation Factor + Cable Loss + LISN Factor)

Margin = 73.0dB μ V – (50dB μ V + 10dB + 2.5dB + 0.5dB)

Margin = 10.0 dB (pass)

Client	Ecobee Inc.	 Canada
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Applicable Standards, Specifications and Methods

ANSI C63.4:2014 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10:2013 American National Standard For Testing Unlicensed Wireless Devices

CFR 47 FCC 15 Subpart C:2015 Code of Federal Regulations – Radio Frequency Devices, Intentional Radiators

CISPR 22:2008 Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement

ICES-003 Issue 6 2016 Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard

RSS-GEN Issue 4 2014 General Requirements and Information for the Certification of Radio Apparatus

RSS-247 Issue 2:2017 Issue 2: Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS 102 Issue 5 2015 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

FCC KDB 447498 v06 RF Exposure Procedures And Equipment Authorization Policies For Mobile And Portable Devices

ISO 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories

Client	Ecobee Inc.
Product	EB-SMSWV-01
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015



Document Revision Status

Revision 000 - December 17, 2017
Initial Release

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxiliary Equipment. A digital accessory that feeds data into or receives data from another device (host) that in turn, controls its operation.

BW – Bandwidth. Unless otherwise stated, this is refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility. The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

EMI – Electro-Magnetic Immunity. The ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

EUT – Equipment Under Test. A device or system being evaluated for compliance that is representative of a product to be marketed.

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line Impedance Stabilization Network

NCR – No Calibration Required

RF – Radio Frequency

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada labs near Toronto, Ontario. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT that has a maximum width or length of up to 2m and a height of up to 3m. The chamber is equipped with a turntable that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120Vac and 240Vac single phase, or devices that are rated for a 208Vac 3 phase input. DC capability is also available for testing. The chamber is equipped with a mast that controls the polarization and height of the antenna. Control of the mast occurs in the control room adjoining the shielded chamber. Radiated emission measurements are performed using a BiLog antenna and a Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN and using the Vertical Ground plane if applicable.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, CA6844), Industry Canada (IC, 6844A-3) and Voluntary Control Council for Interference (VCCI, R-4023, G-506, C-4498, and T-1246). This chamber was calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at TÜV SÜD Canada. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada Inc is accredited to ISO 17025 by A2LA with Testing Certificate #2555.01. The laboratory's current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Testing Environmental Conditions and Dates

Following environmental conditions were recorded in the facility during time of testing

Date	Test	Initials	Temperature (°C)	Humidity (%)	Pressure (kPa)
2017/12/11	Radiated Emissions (9 kHz – 1 GHz)	MX	22.3	11.2	100.7
2017/11/10	Radiated Emissions (Above 1 GHz)	MX	21.5	21.2	102.1
2017/11/16	Antenna Conducted Emissions	MX	21.6	28.9	100.5
2017/12/11	Power Line Conducted Emissions	MX	22.3	11.2	100.7

Client	Ecobee Inc.	
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada

Detailed Test Results Section

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Channel Carrier Bandwidth

Purpose

The purpose of this test is to allow for results that is used to help establish other limits. Although there is not specific limit for this requirement, the derived limits dependant on this information helps allow for other spread spectrum devices to co-exist in the same frequency spectrum.. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits and Methods

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1). The test method is a defined in ANSI C63.10.

The maximum allowed 20 dB bandwidth for frequency hopping system operating in the 902 to 928 MHz band is 500 kHz.

Results

The EUT passed. The maximum 20 dB BW measured was 90.54 kHz.

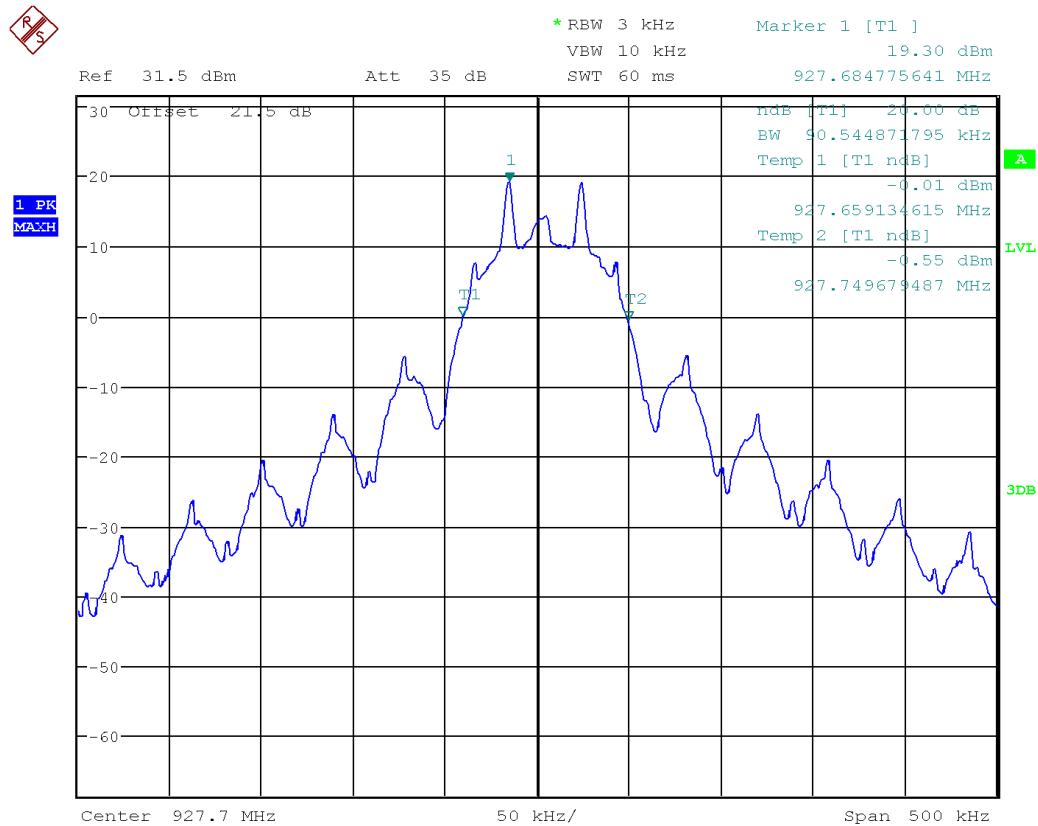
Channel	Frequency (MHz)	20 dB BW (kHz)	99% BW (kHz)	20 dB BW Limit (kHz)	Pass/Fail
0	902.8	88.94	88.14	500	Pass
35	915.1	88.14	88.14	500	Pass
71	927.7	90.54	88.14	500	Pass

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Graph(s)

The graphs shown below shows the 20 dB bandwidth during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 20 dB bandwidth of a channel during operation of the EUT. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute.

20 dB Bandwidth: Channel 0



Date: 16.NOV.2017 11:59:00

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Ecobee Inc.	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada
Product	EB-SMSWV-01		
Standard(s)			

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration / Verification date	Next calibration/ Verification due date	Asset #
26.5GHz Spectrum Analyzer	FSU26	Rohde & Schwarz	Feb-15, 2017	Feb-15, 2019	GEMC 232
20 dB attenuator (SMA)	3M-20	Weinschel	NCR	NCR	GEMC 280

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Carrier Frequency Separation

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits and method

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1). The test method is as defined in ANSI C63.10.

	902 to 928 MHz	2400 to 2483.5 MHz	5275 to 5850 MHz
No conditions	25 kHz or 20 dB BW ¹	25 kHz or 20 dB BW ¹	25 kHz or 20 dB BW ¹
< 125 mW	--	25 kHz or 2/3 of 20 dB BW ¹	--

Note 1: The minimum channel separation is given by the greater of 25 kHz or 20 dB BW for unconditional operation. The 20 dB BW of the system was measured to be 90.54 kHz, so a channel separation limit of 90.54 kHz applies.

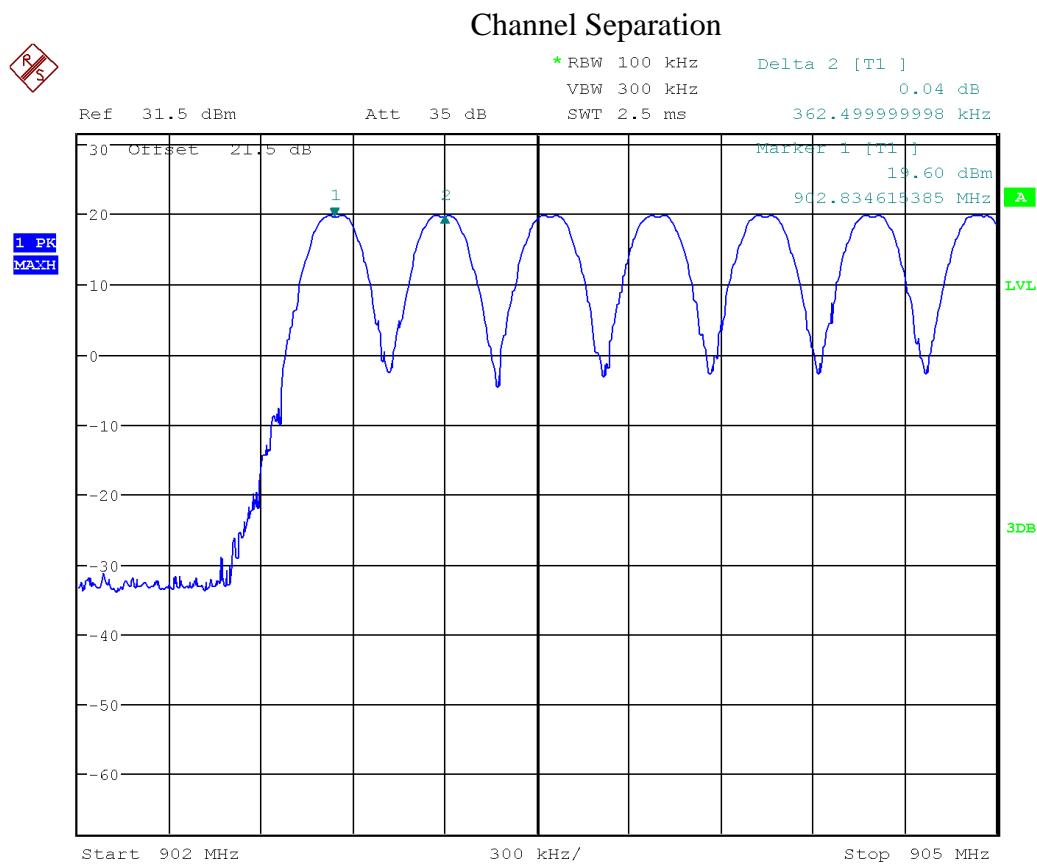
Results

The EUT passed the requirements of channel carrier spacing exceeding the measured 20 dB BW of the EUT. The 20 dB BW previously measured was 90.54 kHz and the device had a minimum channel spacing of 362.50 kHz.

Client	Ecobee Inc.	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada
Product	EB-SMSWV-01		
Standard(s)			

Graph(s)

The graphs shown below shows the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute, as the device is stepping through its hopping table.



Date: 16.NOV.2017 11:13:23

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Ecobee Inc.	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada
Product	EB-SMSWV-01		
Standard(s)			

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration / Verification date	Next calibration/ Verification due date	Asset #
26.5GHz Spectrum Analyzer	FSU26	Rohde & Schwarz	Feb-15, 2017	Feb-15, 2019	GEMC 232
20 dB attenuator (SMA)	3M-20	Weinschel	NCR	NCR	GEMC 280

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Number of Hopping Frequencies

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits and method

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1). The test method is as defined in ANSI C63.10.

	902 to 928 MHz	2400 to 2483.5 MHz	5275 to 5850 MHz
No conditions	≥ 50 channels	≥ 15 channels	≥ 75 channels
20 dB BW exceeds 250 kHz	≥ 25 channels	≥ 15 channels	≥ 75 channels

Results

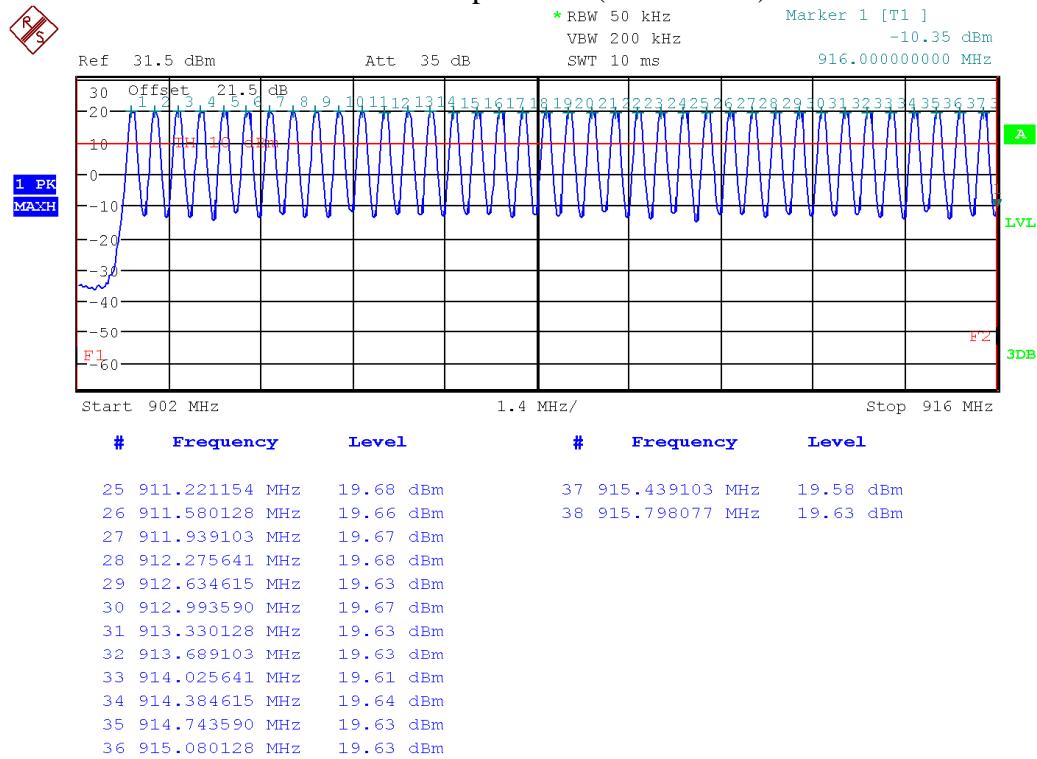
The EUT passed the requirements of the number of channels. The number of channels the device occupies is 72 channels in the allocation band of 902 to 928 MHz.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Graph(s)

The graphs shown below shows the number of occupied channels during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. Max hold is performed for a duration of not less than 10 minutes, or as sufficient to capture the channels occupied.

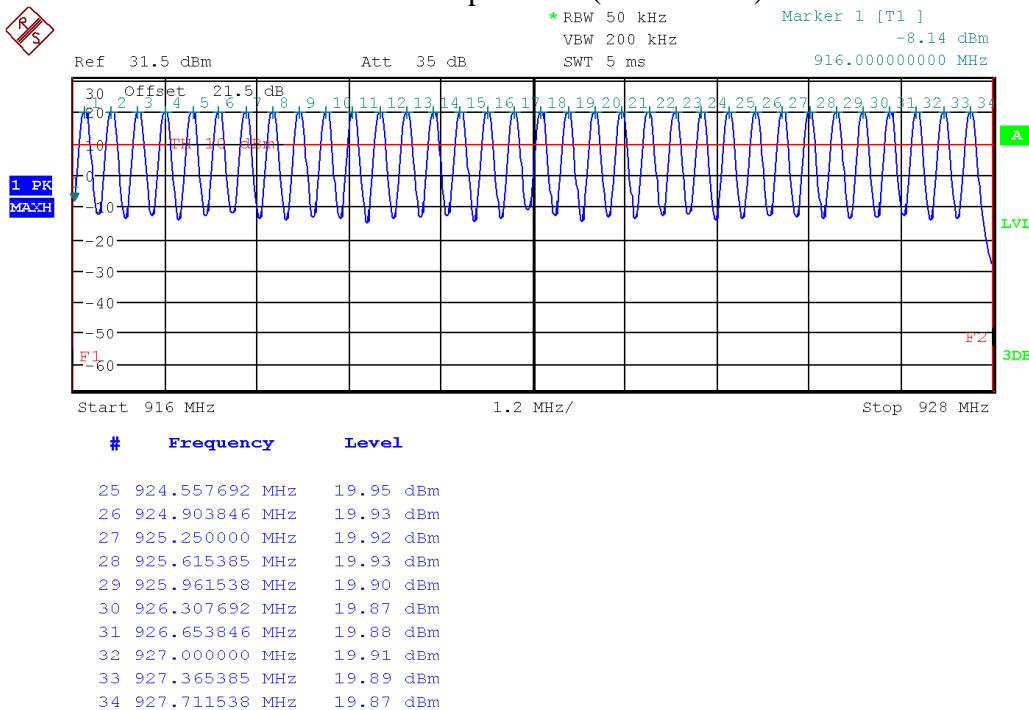
Graph 1 of 2 (38 channels)



Date: 16.NOV.2017 12:20:14

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Graph 2 of 2 (34 channels)



Date: 16.NOV.2017 13:29:00

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration / Verification date	Next calibration/ Verification due date	Asset #
26.5GHz Spectrum Analyzer	FSU26	Rohde & Schwarz	Feb-15, 2017	Feb-15, 2019	GEMC 232
20 dB attenuator (SMA)	3M-20	Weinschel	NCR	NCR	GEMC 280

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Time of Occupancy

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is hopping at a minimum defined rate. This helps ensure sufficient time off to enable other frequency hopping devices to co-operate within this allocated band.

Limits

For 902 to 928 MHz systems, the limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1)(i).

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

The 20 dB bandwidth of the system is <250 kHz and have more than 50 channels; therefore the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Results

The EUT passed the requirements. The maximum average time of occupancy is 0.1 seconds.

The EUT cycles through its pseudo-random generated list of hopping frequencies. There are 72 channels occupied in total. The average transmit time is 5.51 ms per channel and each channel is repeated every 1461.5 ms.

The analyzer sweep time is 2000 ms.

There are 2 hops on the spectrum analyzer.

Number of hops in 20 s = (number of hops on spectrum analyzer) \times (period specified in the requirements / analyzer sweep time)

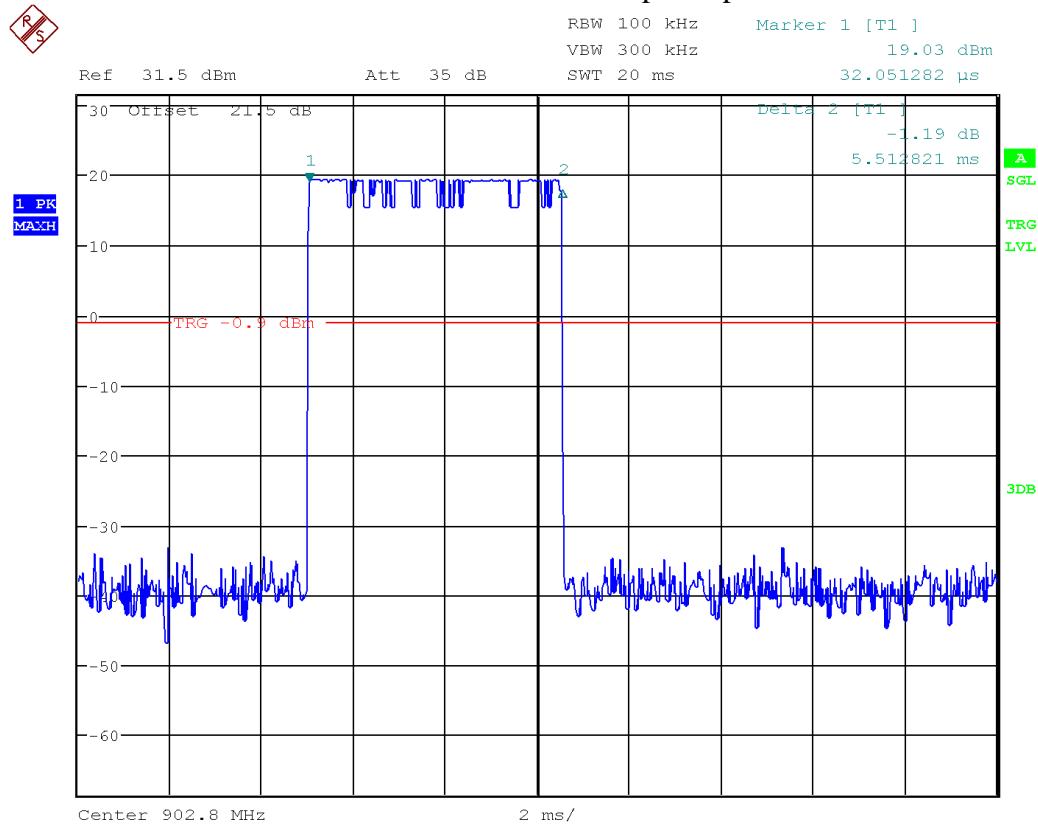
Number of hops in 20 s = $2 \times (20000/2000) = 20$

Client	Ecobee Inc.	 Canada
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Average time of occupancy = $20 \times 5.51 \text{ ms} = 110.2 \text{ ms}$

Graph(s)

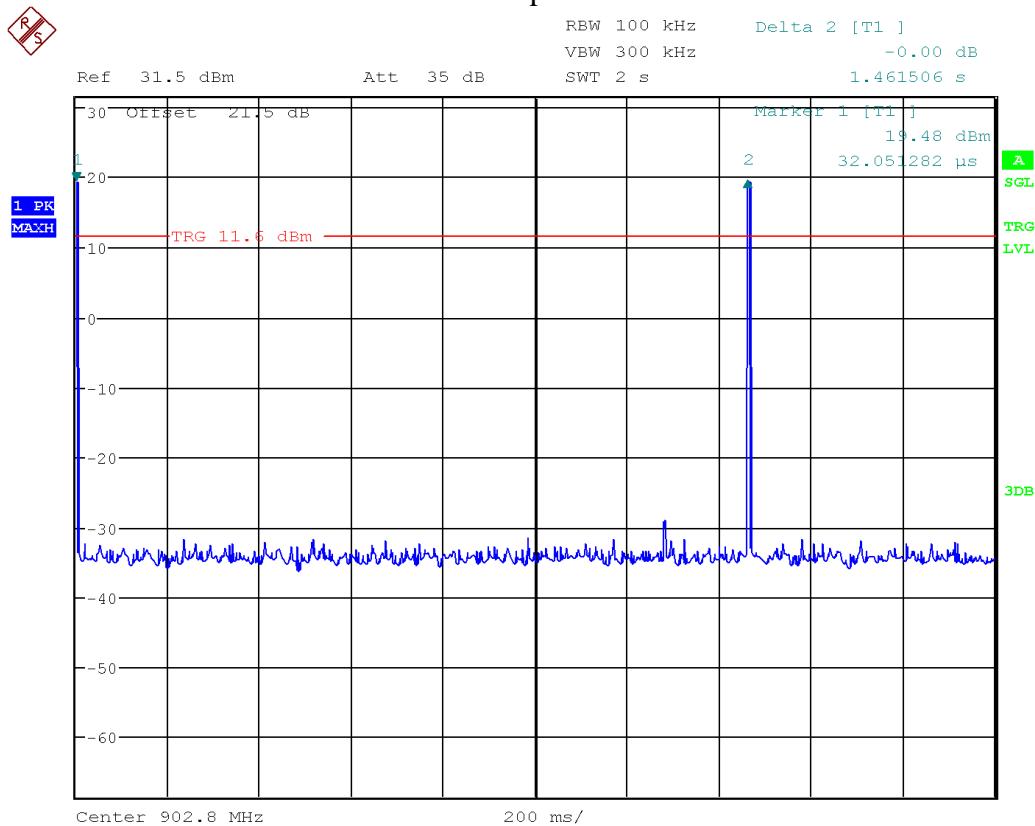
Transmit time per hop



Date: 16.NOV.2017 14:27:09

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Repetition Rate



Date: 16.NOV.2017 14:44:05

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Ecobee Inc.	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada
Product	EB-SMSWV-01		
Standard(s)			

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration / Verification date	Next calibration/ Verification due date	Asset #
26.5GHz Spectrum Analyzer	FSU26	Rohde & Schwarz	Feb-15, 2017	Feb-15, 2019	GEMC 232
20 dB attenuator (SMA)	3M-20	Weinschel	NCR	NCR	GEMC 280

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Maximum Peak Envelope Conducted Power - FHSS

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified.

Limits and methods

The limits are defined in 15.247(b).

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

The test method is a defined in ANSI C63.10.

Results

The EUT passed. The peak power measured was 20.05 dBm (101.16 mW).

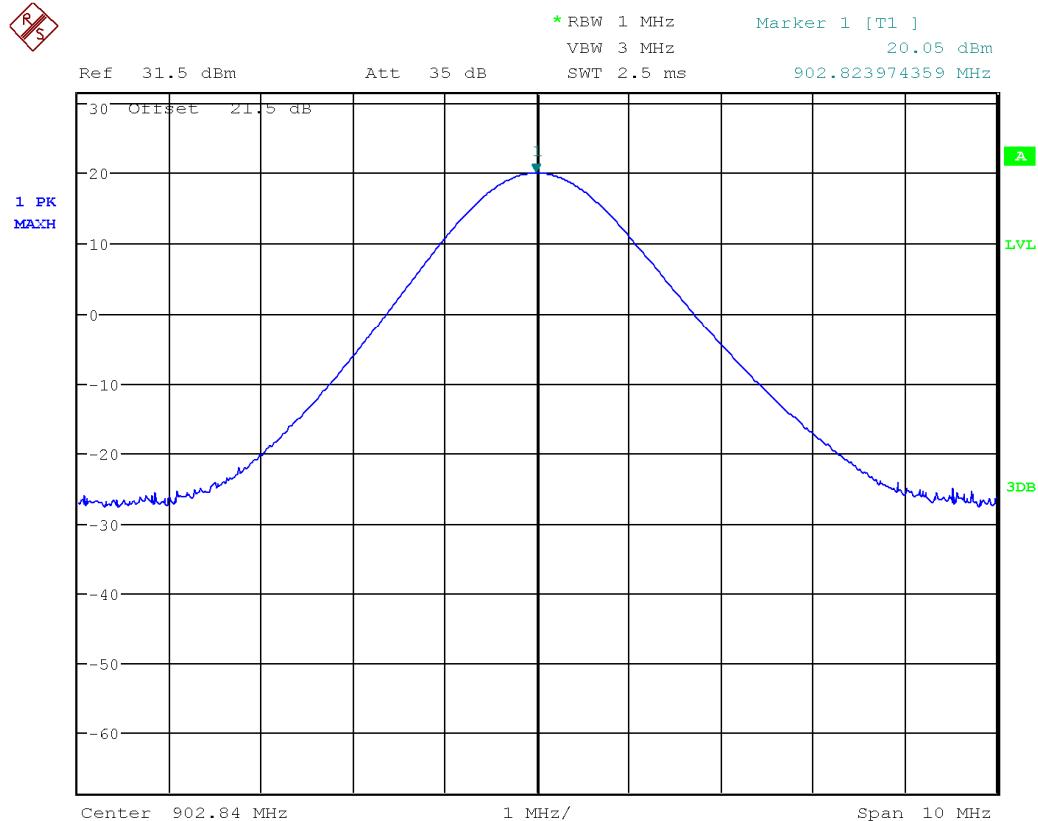
Channel	Frequency (MHz)	Power (dBm)	Power (mW)	Limit (mW)	Pass/Fail
0	902.8	20.05	101.16	1000	Pass
35	915.1	19.97	99.31	1000	Pass
71	927.7	19.57	90.57	1000	Pass

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Measurement(s)

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.

Antenna Conducted Power: Channel 0



Date: 15.NOV.2017 17:51:57

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Ecobee Inc.	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada
Product	EB-SMSWV-01		
Standard(s)			

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration / Verification date	Next calibration/ Verification due date	Asset #
26.5GHz Spectrum Analyzer	FSU26	Rohde & Schwarz	Feb-15, 2017	Feb-15, 2019	GEMC 232
20 dB attenuator (SMA)	3M-20	Weinschel	NCR	NCR	GEMC 280

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Ecobee Inc.
Product	EB-SMSWV-01
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015



Antenna Spurious Conducted Emissions (-20 dBc Requirement) – 15.247

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that only the intended signal is delivered to the radiating element.

Limits and Methods

The limits are defined in 15.247(d). In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Spurious Conducted emissions are to be evaluated up to the 10th harmonic. This -20 dBc requirement also applies at the 'band edge'. Band edge testing shall be performed with the EUT in hopping and in single channel modes.

The method is given in and ANSI C63.10

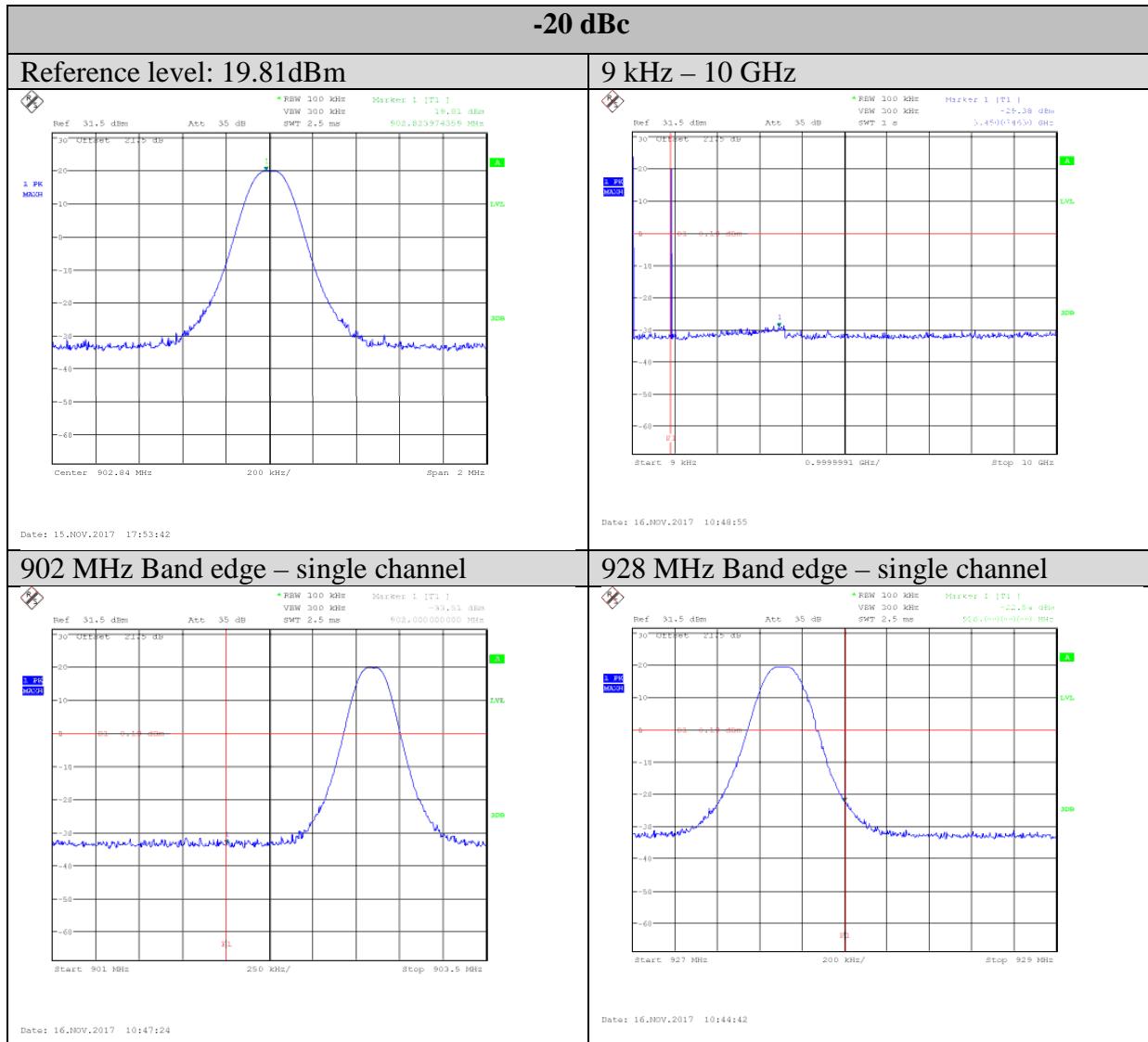
Results

The EUT passed the limits. Low, middle and high channels were measured. The worst case was presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 902 MHz in the low band. The -20 dBc requirement is also shown for the higher band edge at 928 MHz in the high band.

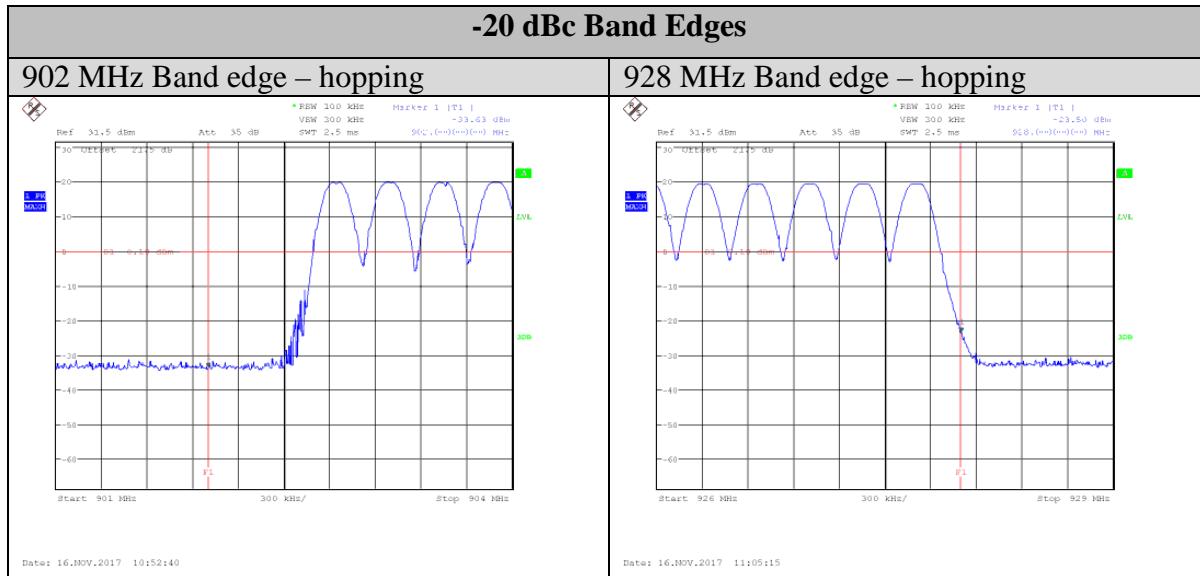
Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Graph(s)

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.



Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration / Verification date	Next calibration/ Verification due date	Asset #
26.5GHz Spectrum Analyzer	FSU26	Rohde & Schwarz	Feb-15, 2017	Feb-15, 2019	GEMC 232
20 dB attenuator (SMA)	3M-20	Weinschel	NCR	NCR	GEMC 280

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Radiated Emissions – 15.247

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit and Method

The method is given in Section 12.1 of FCC KDB 558074 and ANSI C 63.10

The limits are as defined in FCC Part 15, Section 15.209:

The limits, as defined in 15.247(d) for unintentional radiated emissions apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

All unintentional emissions must also meet the ‘Spurious Conducted Emissions’ requirements of -20 dBc or greater. See also ‘Spurious Conducted Emissions’ for further details.

0.009 MHz – 0.490 MHz, 2400/F (kHz) uV/m at 300 m¹

0.490 MHz – 1.705 MHz, 24000/F (kHz) uV/m at 30 m¹

1.705 MHz – 30 MHz, 30 uV/m at 30 m¹

30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m¹) at 3 m

88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m¹) at 3 m

216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m¹) at 3 m

Above 960 MHz, 500 uV/m (54.0 dBuV/m¹) at 3 m

Above 1000 MHz, 500 uV/m (54 dBuV/m²) at 3m

Above 1000 MHz, 500 uV/m (74 dBuV/m³) at 3m

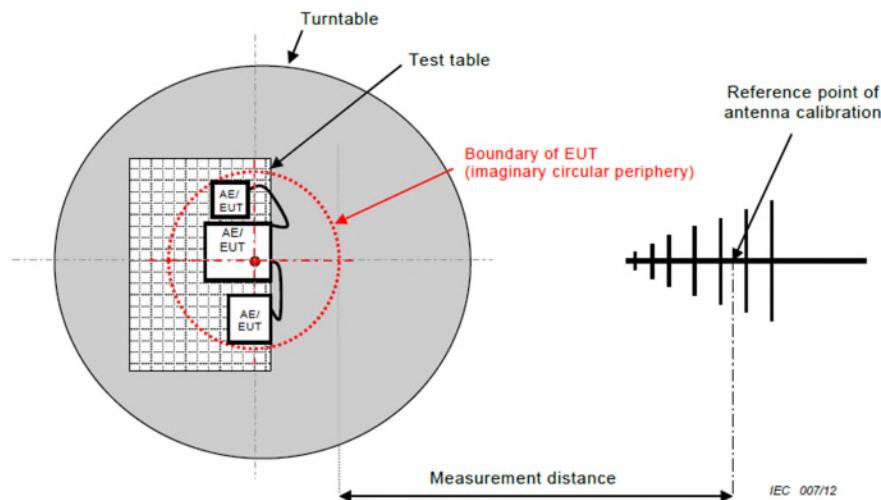
¹Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1

²Limit is with 1 MHz measurement bandwidth and using an Average detector

³Limit is with 1 MHz measurement bandwidth and using a Peak detector

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Typical Radiated Emissions Setup



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater than the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

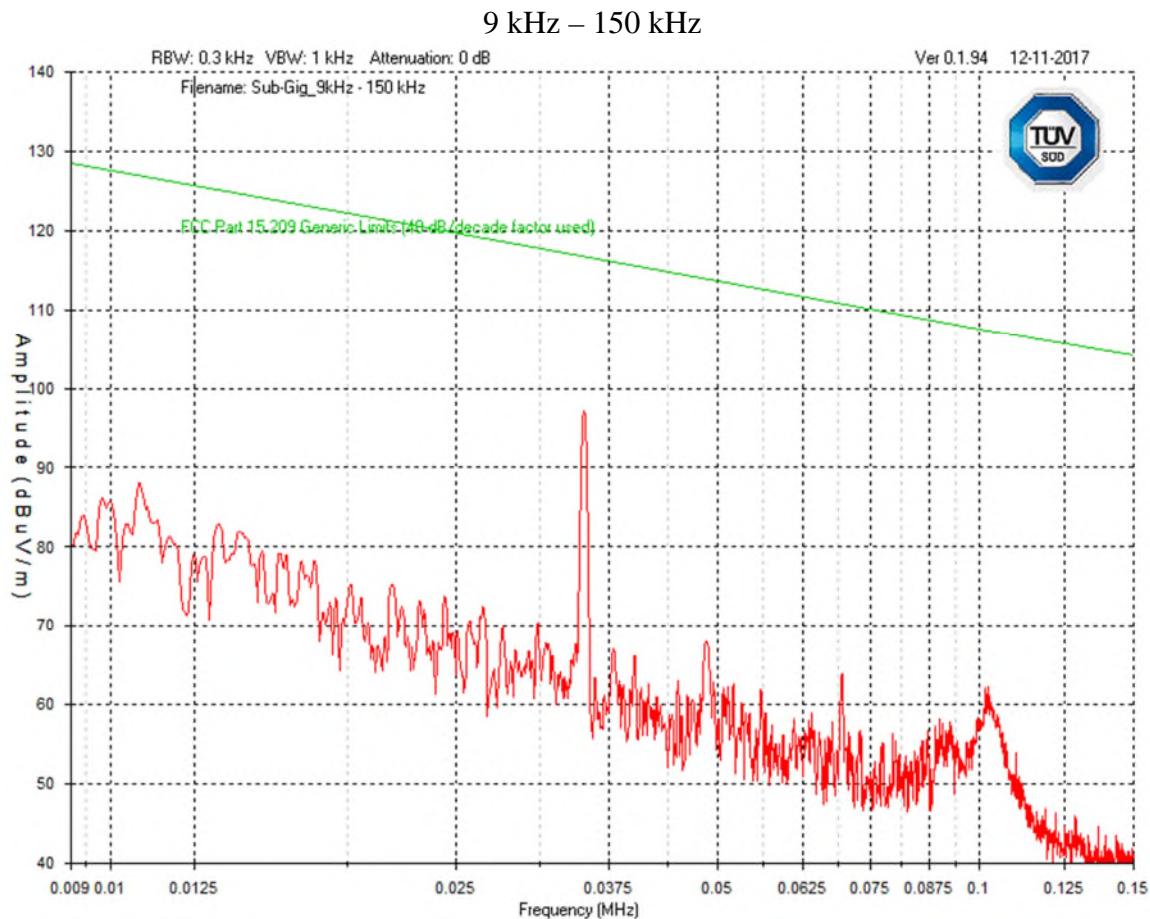
In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10th harmonic.

Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.

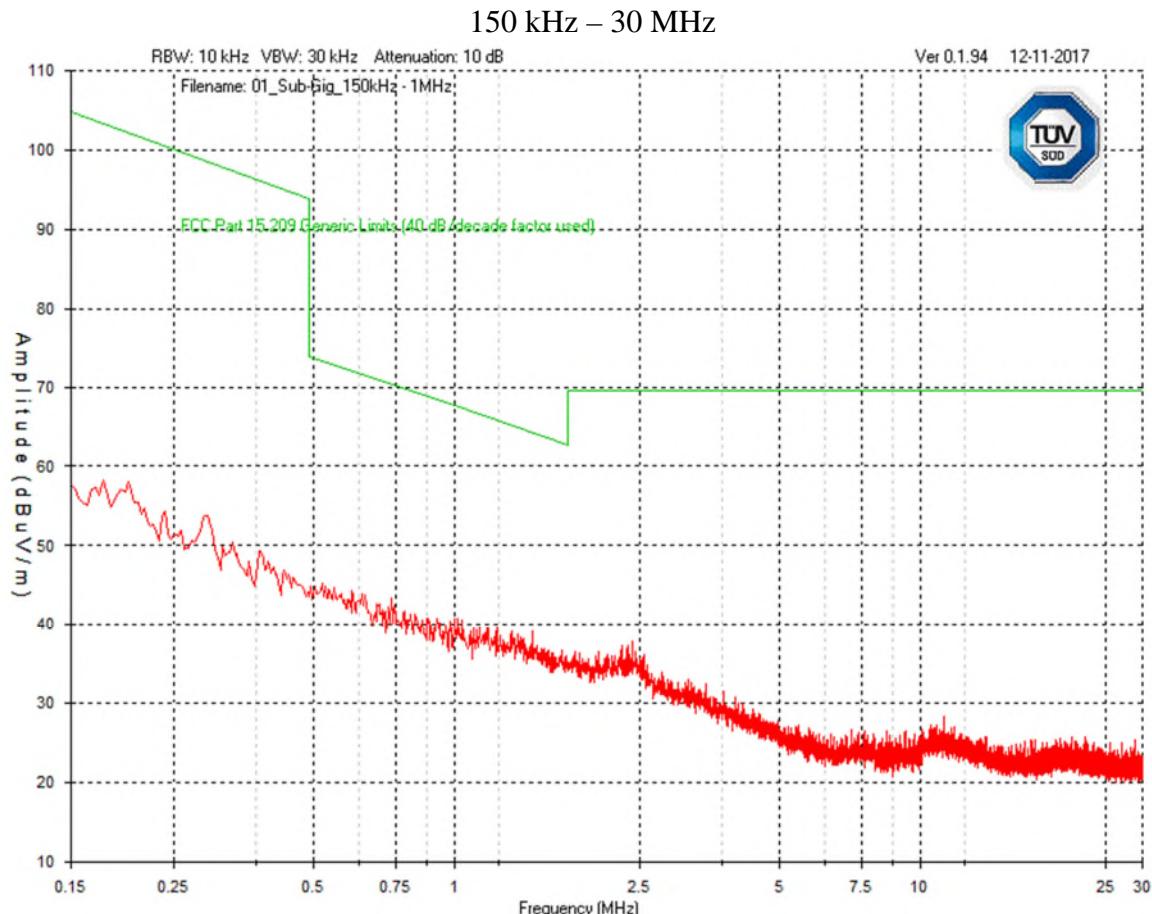
Low, middle and high channels were measured, each in three orthogonal axes were checked; however the worst case graphs are presented.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Band edge measure graphs were shown for illustrations purpose. See final measurement section for all measurements.

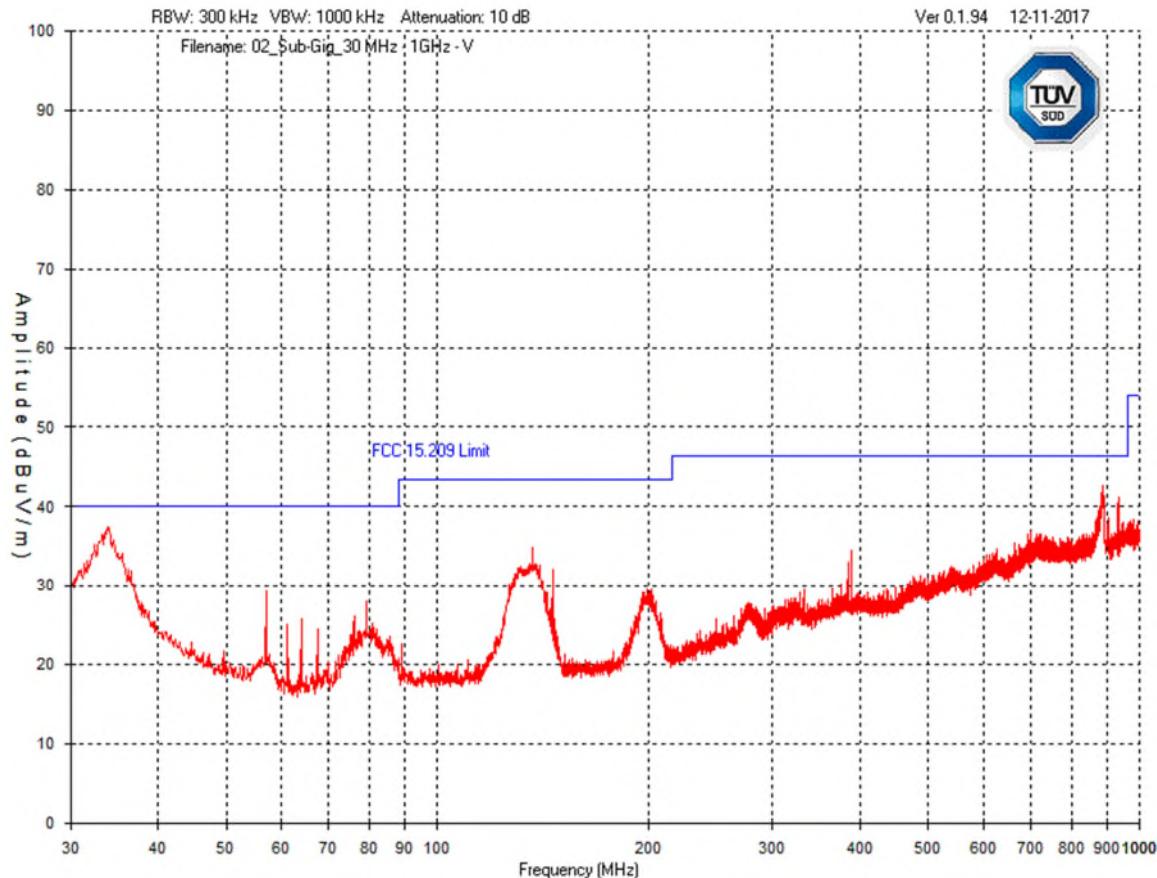


Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	



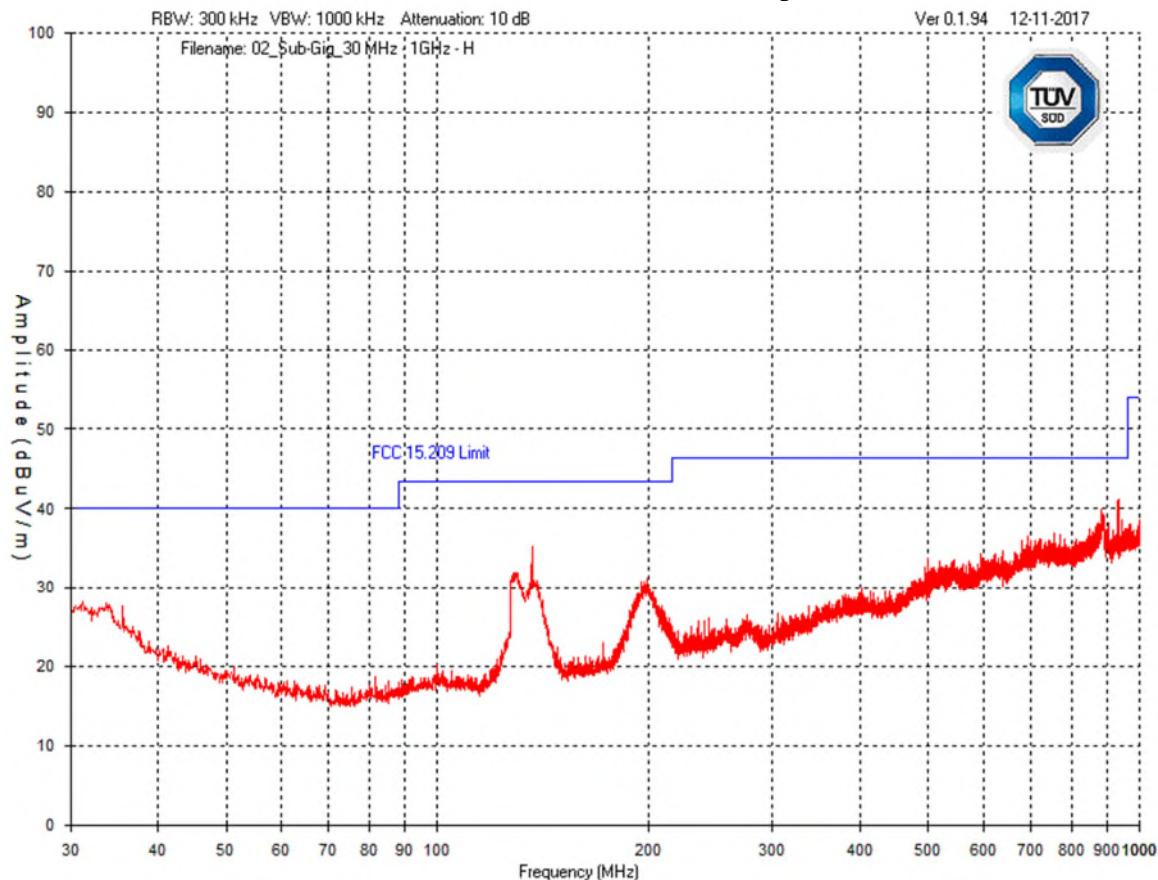
Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Mid Channel - 30 MHz – 1 GHz
Vertical – Peak Emission Graph



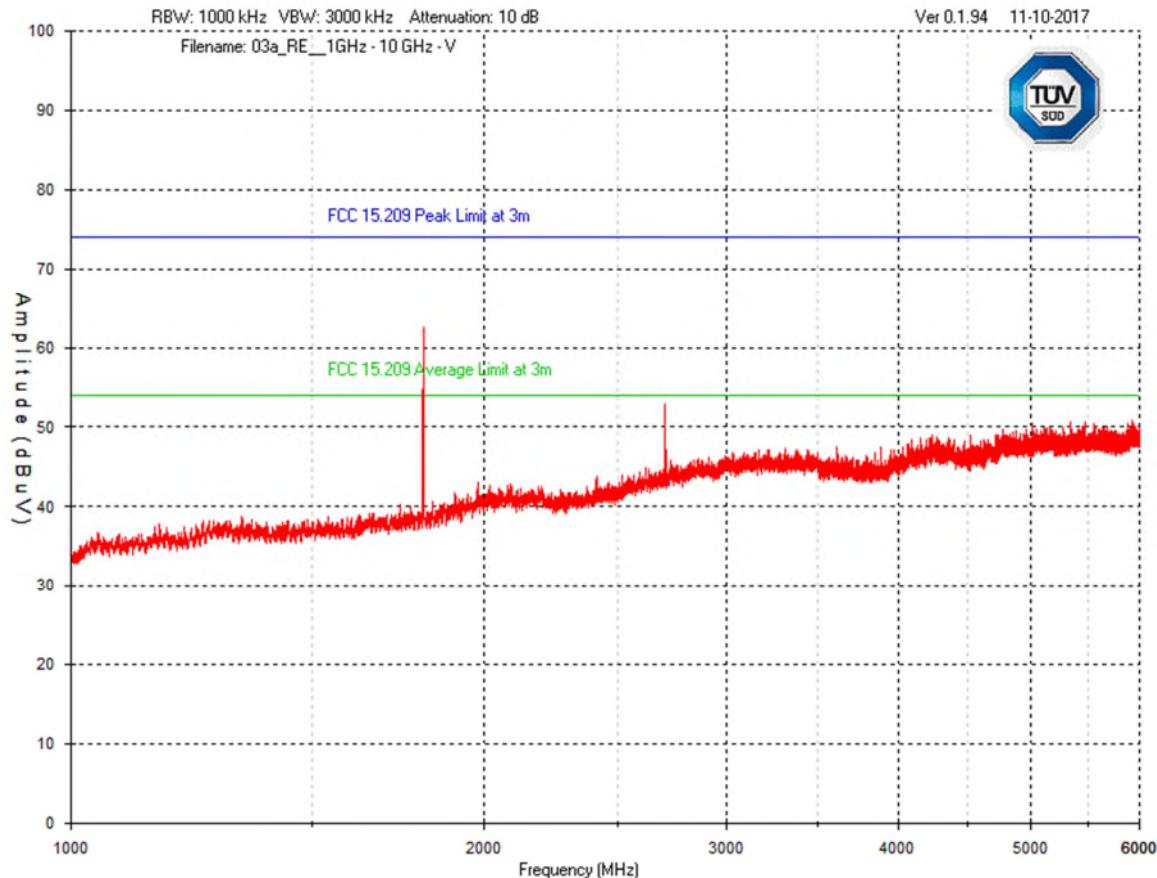
Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Mid Channel – 30 MHz – 1 GHz
Horizontal - Peak Emission Graph



Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

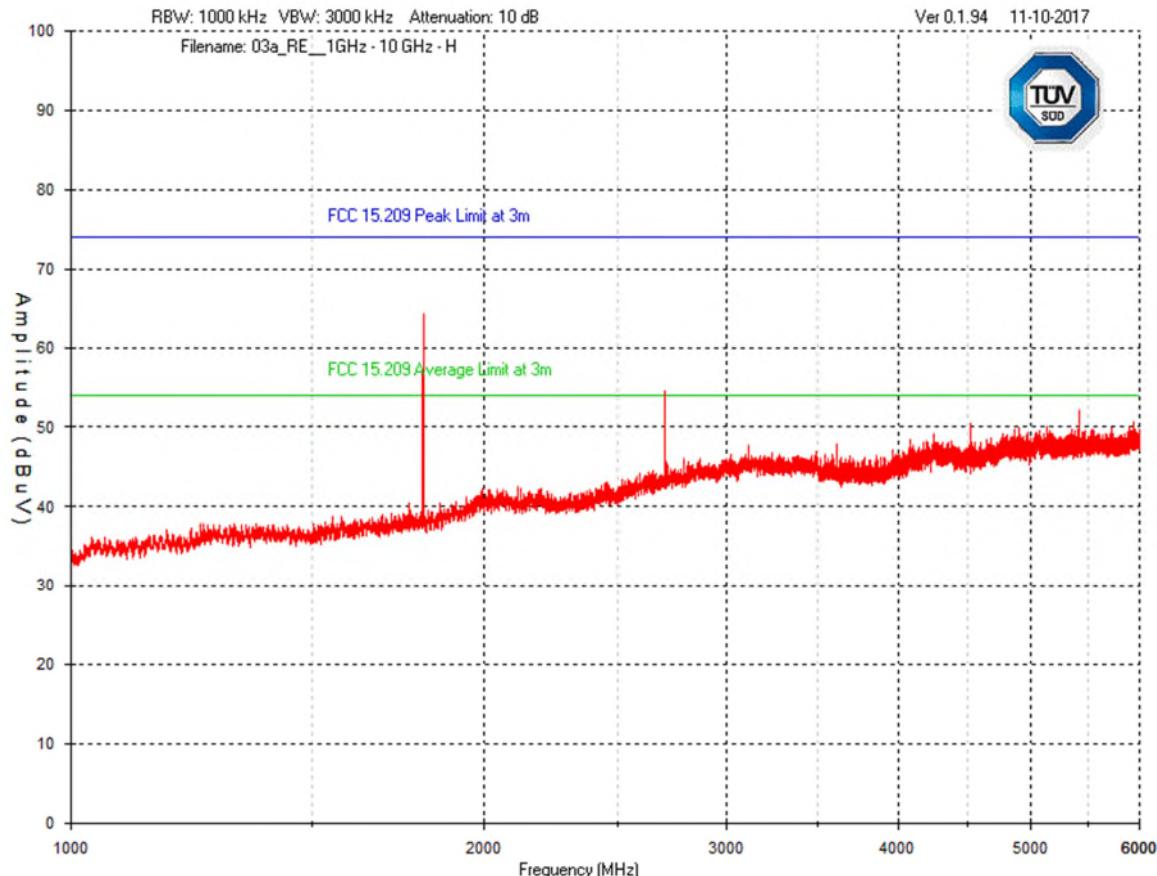
Mid Channel – 1 GHz – 6 GHz
Vertical - Peak Emission Graph



Note: See Final Measurements and Results section starting on page 42 for measurements.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

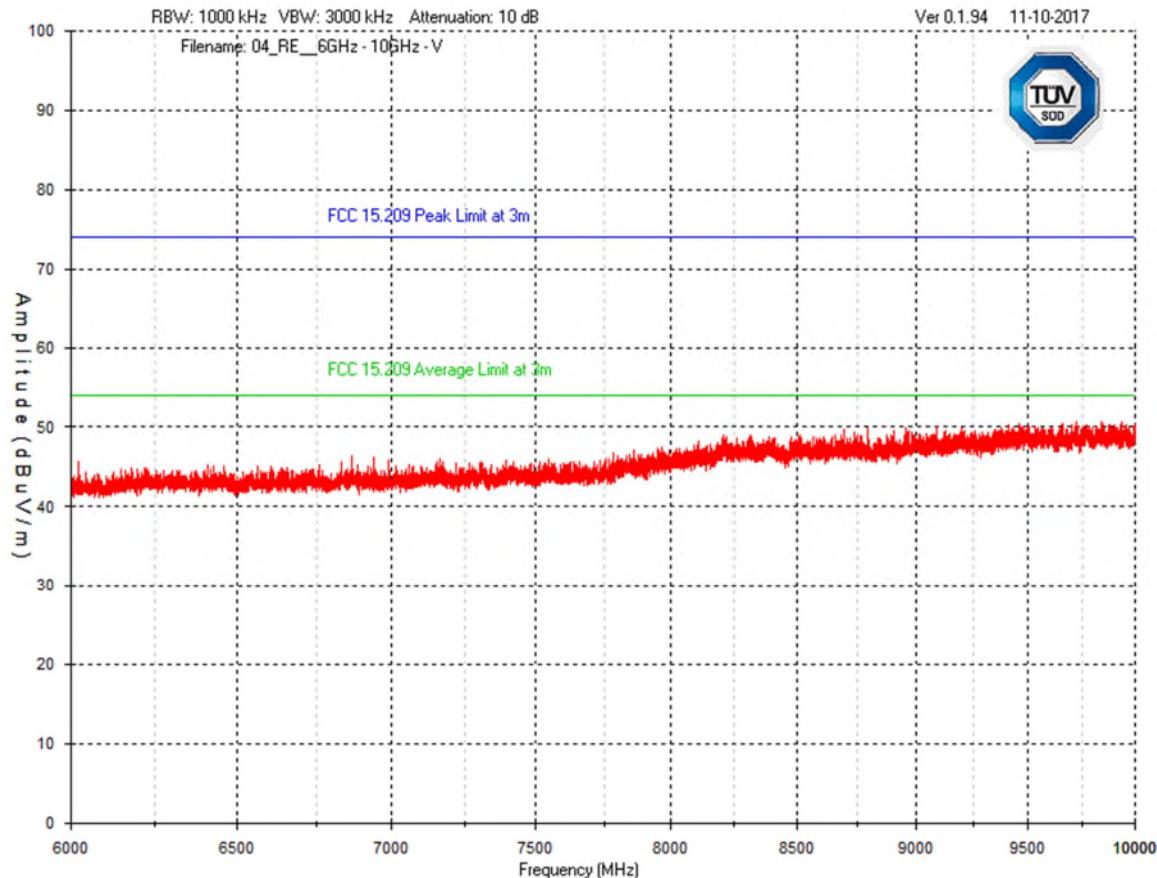
Mid Channel – 1 GHz – 6 GHz
Horizontal - Peak Emission Graph



Note: See Final Measurements and Results section starting on page 42 for measurements.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Mid Channel – 6 GHz – 10 GHz
Vertical - Peak Emission Graph

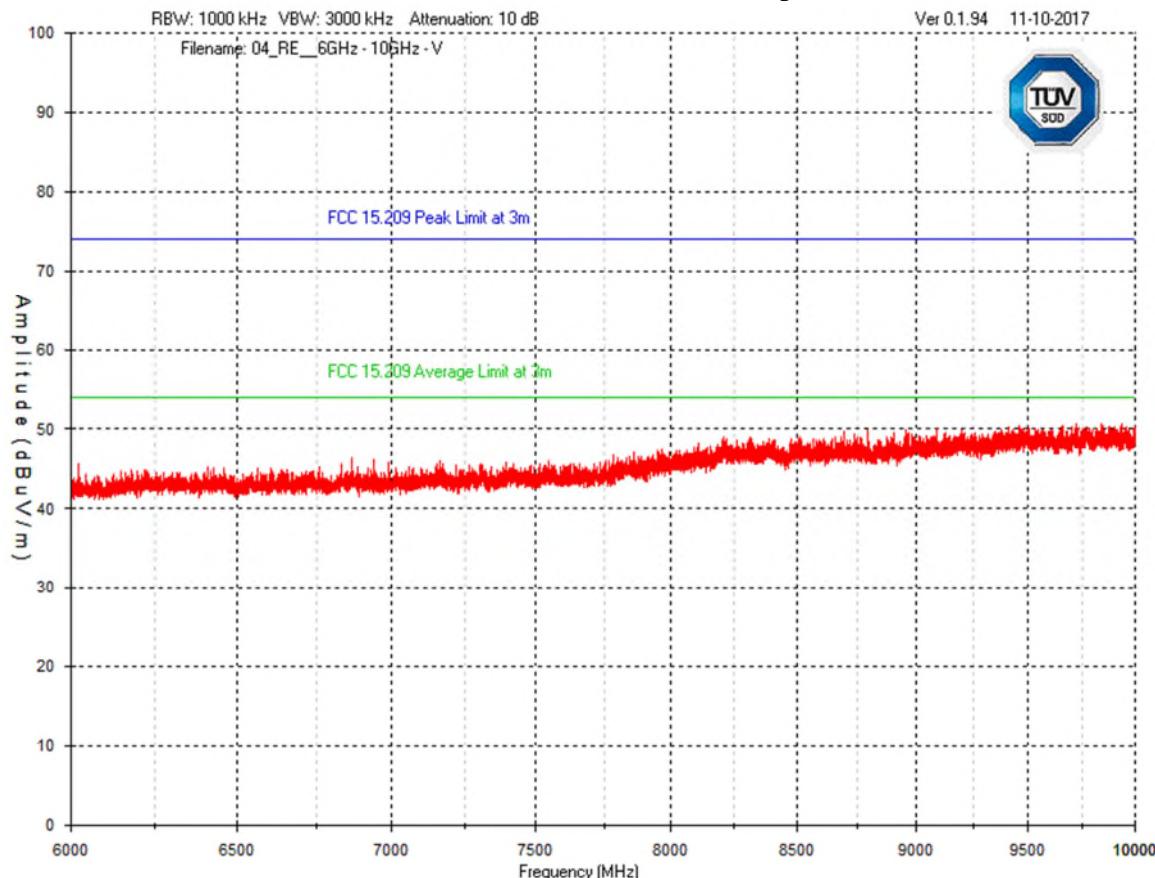


Note: See Final Measurements and Results section starting on page 42 for measurements.

Client	Ecobee Inc.
Product	EB-SMSWV-01
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015



Mid Channel – 6 GHz – 10 GHz Horizontal - Peak Emission Graph



Note: See Final Measurements and Results section starting on page 42 for measurements.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Final Measurements and Results

The EUT passed the limits. Low, middle and high bands were measured.

In accordance with 15.247(d), only frequencies exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a final detector. Emission outside the restricted bands were measured for information purpose.

The measurements were maximized by rotating the turn table over a full 0-360 rotation and the antenna height was varied from 1 m to 4 m.

Supply		120 Vac 60 Hz					
Vertical Emission Table							
Frequency (MHz)	Detector	Raw (dBuV)	Correction Factors (dB)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass/Fail
33.8839	PEAK	44.5	-7.0	37.5	40.0	2.5	Pass
884.94	PEAK	39.1	3.5	42.6	46.4	3.8	Pass
931.741	PEAK	37.4	3.9	41.3	46.4	5.1	Pass
1806.43	AVG	41.5	-4.2	37.3	54.0	16.7	Pass*
2709.83	AVG	26.3	1.4	27.7	54.0	26.3	Pass*

Horizontal Emission Table							
931.644	PEAK	37.3	3.9	41.2	46.4	5.2	Pass
882.61	PEAK	36.4	3.5	39.9	46.4	6.5	Pass
1806.43	AVG	43.1	-4.2	38.9	54.0	15.1	Pass*
2709.83	AVG	27.9	1.4	29.3	54.0	24.7	Pass*
5419.73	AVG	18.4	8.4	26.8	54.0	27.2	Pass*

*This is the 2nd harmonic of the transmitter. The Average emission was derived from adding duty cycle correction factor of -25.2 dB to the peak. The transmitter have an ON time of 5.51 ms in a 100 ms period.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 6, 2016	Jan. 6, 2018	GEMC 233
Loop Antenna	EM 6871	Electro-Metrics	Feb 13, 2017	Feb 13, 2019	GEMC 70
Loop Antenna	EM 6872	Electro-Metrics	Feb 13, 2017	Feb 13, 2019	GEMC 71
BiLog Antenna	HLP-3003C	TDK RF Solutions	Oct. 12, 2016	Oct. 12, 2018	GEMC 231
Horn Antenna 2 – 18 GHz	WBH218HN	Q-par	Feb. 12, 2016	Feb. 12, 2018	GEMC 6375
Horn Antenna 18 GHz - 26.5 GHz	SAS-572	A.H. Systems	Oct 11, 2016	Oct 11, 2018	GEMC 6371
HP Preamplifier	HP-8449B	HP	Oct 27, 2017	Oct 27, 2019	GEMC 297
Band Reject Filter	BRC50722	Micro-Tronics	Apr 9, 2017	Apr 9, 2018	GEMC 186
High pass filter	5IH30-1078	K & L Microwave	Apr 9, 2017	Apr 9, 2018	GEMC 118
RF Cable 7m	LMR-400-7M-50Ω-MN-MN	LexTec	Feb 13, 2017	Feb 13, 2018	GEMC 28
RF Cable 10m	LMR-400-10M-50Ω-MN-MN	LexTec	Feb 13, 2017	Feb 13, 2018	GEMC 27
RF Cable 0.5m	LMR-400-0.5M-50Ω-MN-MN	LexTec	Feb 13, 2017	Feb 13, 2018	GEMC 31
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	Feb 13, 2017	Feb 13, 2018	GEMC 29
9kHz-1GHz, 28dB preamp and power supply	LNA 6901	Teseq	Feb 2, 2017	Feb 2, 2019	GEMC 168
6 dB attenuator	612-06-1	Meca Electronics, Inc.	NCR	NCR	GEMC 286
BiLog Antenna	3142-C	ETS	Oct 6, 2016	Oct 6, 2018	GEMC 8
Emissions Software	0.1.94	Global EMC	NCR	NCR	GEMC 58

This report module is based on template "FCC - 15.209 - Radiated Emissions_Rev1.doc"

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Power Line Conducted Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT's power line does not exceed the limits listed below as defined in the applicable test standard and measured from a LISN. This helps protect lower frequency radio services such as AM radio, shortwave radio, amateur radio, maritime radio, CB radio, and so on, from unwanted interference.

Limits & Method

The method is as defined in ANSI C63.10. The limits are as defined in FCC Part 15 Section 15.207 and RSS-GEN:

Average Limits		Quasi-Peak Limits	
150 kHz – 500 kHz	56 to 46* dB μ V	150 kHz – 500 kHz	66 to 56* dB μ V
500 kHz – 5 MHz	46 dB μ V	500 kHz – 5 MHz	56 dB μ V
5 MHz – 30 MHz	50 dB μ V	5 MHz – 30 MHz	60 dB μ V

* Decreases linearly with the logarithm of the frequency

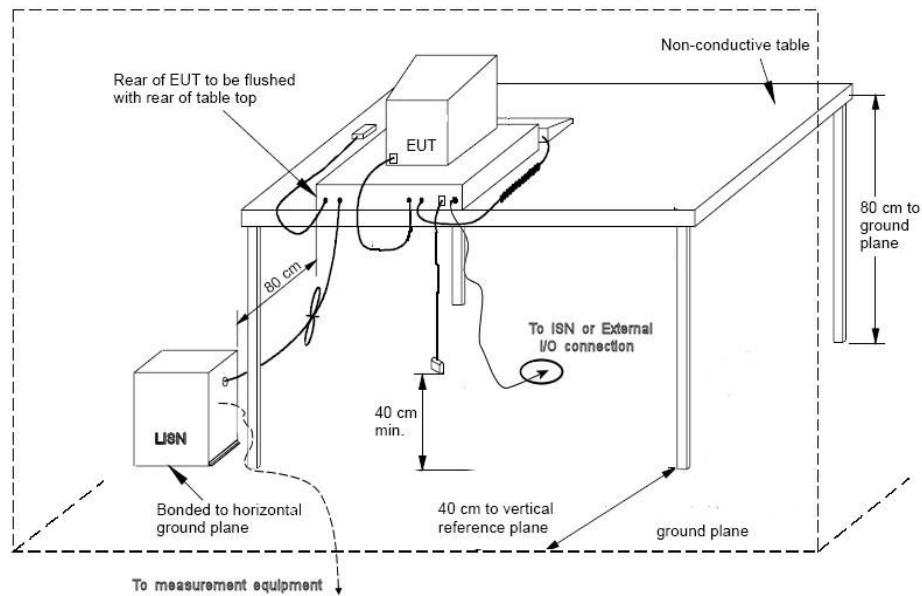
Both Quasi-Peak and Average limits are applicable and each is specified as being measured with a resolution bandwidth of 9 kHz. For Quasi-Peak, a video bandwidth at least three times greater than the resolution bandwidth is used.

If the Peak or Quasi-Peak detector measurements do not exceed the Average limits, then the EUT is deemed to have passed the requirements.

Client	Ecobee Inc.
Product	EB-SMSWV-01
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015



Typical Setup Diagram



Measurement Uncertainty

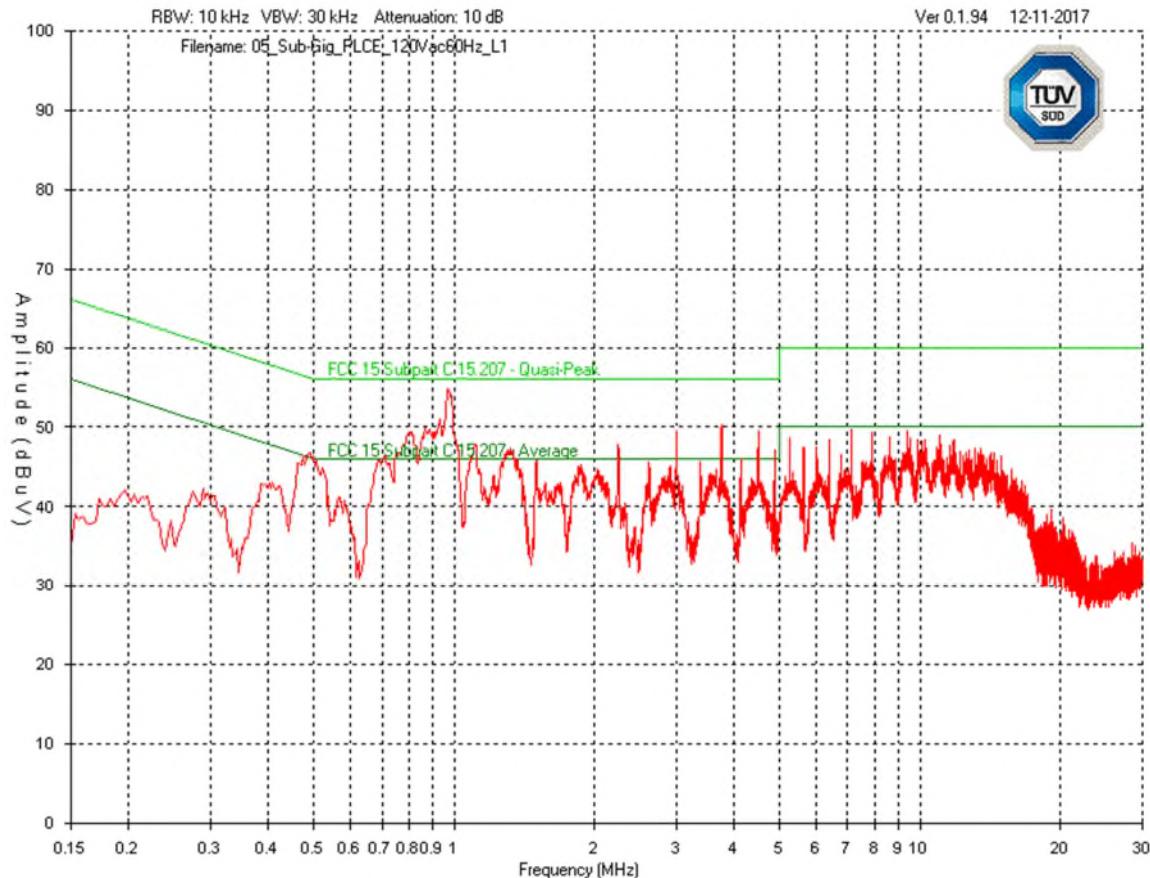
The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is $\pm 2.91\text{dB}$ with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector. This peaking process is done as a worst case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

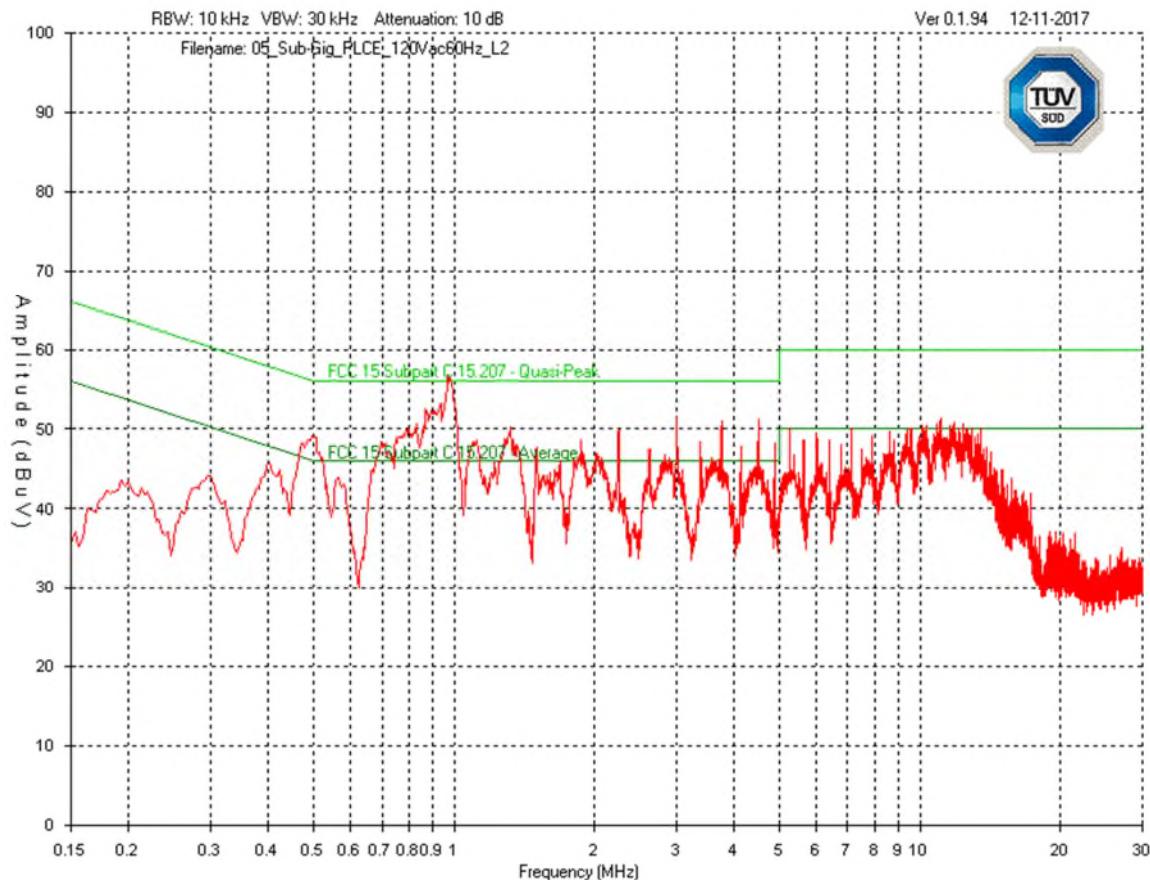
Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Line (L1) – 120Vac 60Hz
Peak Emission



Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart C 15.247:2015	

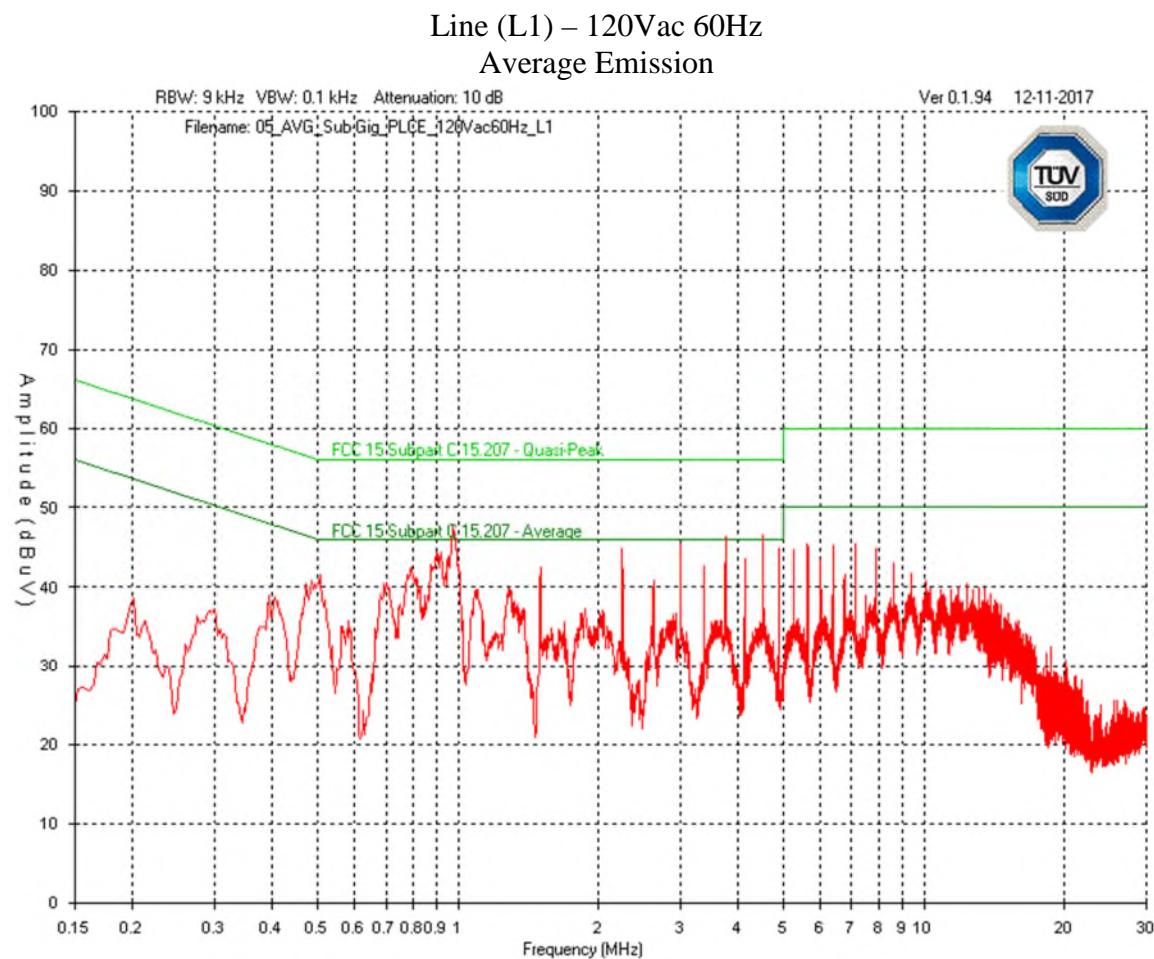
Neutral (L2) – 120Vac 60Hz
Peak Emission



Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

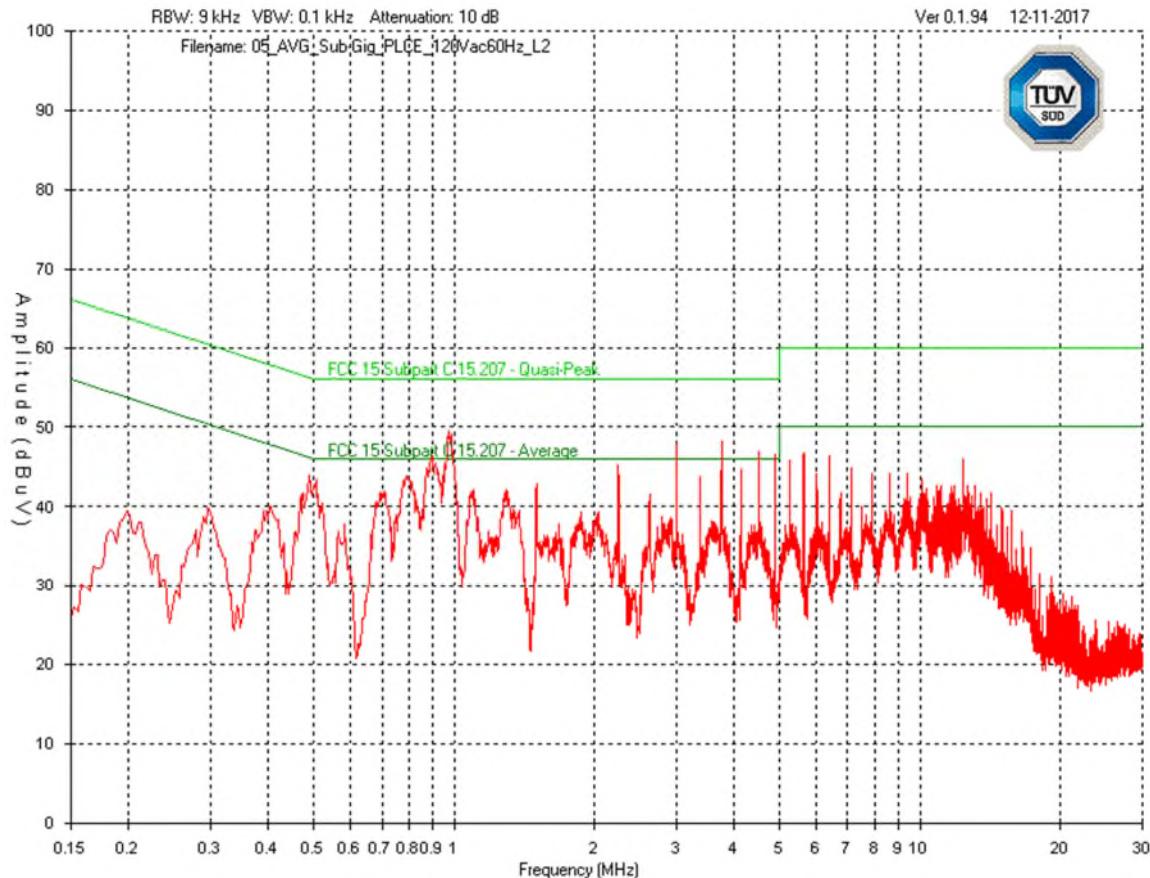
Average Emission Graphs

The following graphs shown below are maximized average measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector and a video bandwidth of 100 Hz. This video averaging process is done as a worst case average measurement and enables the detection of frequencies of concern for final average measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.



Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Neutral (L2) – 120Vac 60Hz
Average Emission



Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

Final Measurements

Supply		120 Vac 60 Hz					
Line Emission Table							
Frequency (MHz)	Detector	Raw (dBuV)	Factors (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Pass/Fail
0.9692	QP	41.1	10.2	51.3	56.0	4.7	Pass
0.9739	AVG	32.4	10.2	42.6	46.0	3.4	Pass
4.5021	AVG	34.1	10.2	44.3	46.0	1.7	Pass
3.7529	AVG	34.5	10.2	44.7	46.0	1.3	Pass
3.0037	AVG	33.9	10.2	44.1	46.0	1.9	Pass
4.8782	AVG	33.3	10.2	43.5	46.0	2.5	Pass
2.2514	AVG	32.3	10.2	42.5	46.0	3.5	Pass
4.129	AVG	32.1	10.2	42.3	46.0	3.7	Pass
3.3798	AVG	29.9	10.2	40.1	46.0	5.9	Pass
0.7948	AVG	27.5	10.2	37.7	46.0	8.3	Pass
1.5022	AVG	29.3	10.2	39.5	46.0	6.5	Pass
Neutral Emission Table							
0.9692	QP	43.3	10.2	53.5	56.0	2.5	Pass
3.0057	QP	38.5	10.2	48.7	56.0	7.3	Pass
4.5048	QP	38.6	10.2	48.8	56.0	7.2	Pass
0.9769	AVG	32.9	10.2	43.1	46.0	2.9	Pass
3.7529	AVG	34.8	10.2	45.0	46.0	1.0	Pass
3.0037	AVG	34.1	10.2	44.3	46.0	1.7	Pass
4.5021	AVG	34.5	10.2	44.7	46.0	1.3	Pass
0.8933	AVG	29.5	10.2	39.7	46.0	6.3	Pass
4.8812	AVG	33.0	10.2	43.2	46.0	2.8	Pass
2.2544	AVG	32.4	10.2	42.6	46.0	3.4	Pass
4.129	AVG	31.8	10.2	42.0	46.0	4.0	Pass
0.4873	AVG	26.8	10.2	37.0	46.2	9.2	Pass
0.7888	AVG	27.8	10.2	38.0	46.0	8.0	Pass
3.3768	AVG	29.9	10.2	40.1	46.0	5.9	Pass
1.5022	AVG	29.7	10.2	39.9	46.0	6.1	Pass
5.6335	AVG	33.7	10.2	43.9	50.0	6.1	Pass
6.3797	AVG	33.6	10.2	43.8	50.0	6.2	Pass
1.2903	AVG	25.4	10.2	35.6	46.0	10.4	Pass

Client	Ecobee Inc.	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada
Product	EB-SMSWV-01		
Standard(s)			

1.1022	AVG	25.6	10.2	35.8	46.0	10.2	Pass
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See 'Appendix B – EUT, Peripherals and Test Setup Photos' for photos showing the test set-up for the highest line conducted emission

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	FSU3	Rohde & Schwarz	Feb 7, 2017	Feb 7, 2019	GEMC 198
LISN	FCC-LISN-50-100-1-02-MS461F	FCC	Feb. 5, 2016	Feb. 5, 2018	GEMC 121
LISN	FCC-LISN-50-100-1-02-MS461F	FCC	Feb. 5, 2016	Feb. 5, 2018	GEMC 122
RF Cable 7m	LMR-400-7M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 28
10dB Attenuator	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Emissions Software	0.1.94	TUV SUD Canada	NCR	NCR	GEMC 58

This report module is based on report template 'FCC_ICES003_CE_Rev1'

Client	Ecobee Inc.	
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	 Canada

Appendix A – EUT Summary

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

For further details for filing purposes, refer to filing package.

General EUT Description

Client	
Organization / Address	Ecobee Inc 250 University Avenue, Suite 400 Toronto, ON M5H 3E5
Contact	Kashif Ahmed
Phone	416 987 1048
Email	kashif@ecobee.com
EUT Details	
EUT Name	EB-SMSWV-01
FCC ID	WR9EBSMSW1V001
Industry Canada #	7981A- EBSMSW1V001
Equipment Category	Unlicensed transmitter
Basic EUT Functionality	EUT is a smart light switch that have a 2400 – 2483.5 MHz DTS (802.11 b/g/n) transmitter and a 902 – 928 MHz FHSS transmitter.
Input Voltage and Frequency	120 Vac 60 Hz
Rated Input Current	2 A
Connectors available on EUT	None
Peripherals Required for Test	None
Release type	Final
Intentional Radiator Frequency	2400 – 2483.5 MHz for 802.11 b/g/n DTS 902 – 928 MHz FHSS
EUT Configuration	Wireless configured to transmit continuously at max duty cycle

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see ‘Appendix B – EUT and Test Setup Photos’.

Client	Ecobee Inc.	 Canada
Product	EB-SMSWV-01	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247:2015	

EUT Configuration

Please see Appendix B for a picture of the unit running in normal conditions.

- Wireless were configured to transmit at maximum possible duty cycle
- The 15.247 902 – 928 MHz transmitter were configured with the following settings:
 - A special test firmware were installed on the EUT to control hopping through its pseudo random sequence and single channel

Operational Setup

These devices are required to be attached to the EUT for its normal operation.

- A debug board was connected to the EUT to issue test commands.